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ABSTRACT

An investigation was made to evaluate the suitability of using various submethods with volatile-corrosion-inhibitor-treated materials in the packaging of small arms components. Packages were stored under two conditions: (1) in an outdoor shed to simulate minimum warehouse storage and (2) in a static humidity cabinet to simulate tropic storage. Heat-sealable polyester film with volatile-corrosion-inhibitor innerwrap provided satisfactory protection in the humidity cabinet for one year. Results of this investigation indicate that packaging submethods other than those specified in MIL-I-8574 can be satisfactorily used with VCI preservatives. Test procedures are described and results given.

CONTENTS

REPORT
SA-TR20-2313

SUBJECT

Investigation of packaging methods and submethods in which volatile-corrosion-inhibitor treated materials were used in a static humidity cabinet and in an outdoor storage shed.

OBJECTIVES

The objective of this study was to investigate the packaging of small arms components with P-9 and P-18 preservatives under storage conditions of both an outdoor shed and a static humidity cabinet. Various methods and submethods described in Specification MIL-P-116 were used in this investigation.

SUMMARY OF CONCLUSIONS

Volatile corrosion inhibitor material was used with various packaging submethods and materials in the static humidity cabinet and in the outdoor storage shed for tests of one and three years, respectively. These testing conditions were used to simulate indeterminate storage conditions encountered with Level A preservation and packing.

Submethod 1A-8 and 1A-15, as well as a polyester film laminated on both sides with polyethylene, provided satisfactory protection in the humidity cabinet when volatile-corrosion-inhibitor innerwrap was used. Also Submethod 1C-2 provided some protection under identical conditions. Clear polystyrene vials were not satisfactory for either the humidity cabinet or the outdoor storage shed. Submethod 1C-1, 1C-5, and 1C-5 (Modified), did not provide satisfactory protection for the components.

The effectiveness of the volatile corrosion inhibitor in the various packs could not be evaluated in the outdoor storage shed since most of the packs with and without volatile corrosion inhibitor were satisfactory.

RECOMMENDATIONS

1. Accelerated tests <u>not</u> be used as an absolute criterion for evaluating various methods of packaging as set forth in MIL-P-116 (particularly, if volatile corrosion inhibitors are used).

2. Various materials be investigated to evaluate the maximum WVTR (water-vapor transmission rate) value for use with volatile corrosion inhibitor material under long-term indeterminate storage conditions.

RECOMMENDATIONS - Continued

3. Transmission rates of VCI vapors be established for the various flexible films to provide complete information for the most efficient use of this type of packaging material.

I. INTRODUCTION

The use and application of a volatile-corrosion-inhibitor type of preservative, P-18, in accordance with MIL-I-8574 specifically limits the use of MIL-I-3420 material to waterproof-vaporproof barrier materials for Level A protection. Greaseproof and/or waterproof materials conforming to Methods 1 and 1C of MIL-P-116 were investigated with MIL-I-3420 material to determine whether these packaging methods could be satisfactorily utilized for specific small arms components at a Level A protection.

These components had a manganese phosphate metal finish with a P-9 preservative. The protective coating method, when combined with a P-18 preservative, appeared to lend itself to a lower protective packaging level. The individually packaged components were evaluated in a static humidity cabinet and in an outdoor storage shed, as unit packs, and without the added protection afforded by intermediate packs.

II. PROCEDURE

Expendable M1 rifle components consisting of apertures, hammer springs, housings, hammer spring plungers, trigger pins, extractors, butt swivels, housing rear sight covers, trigger housings, latch clips, front swivels, catch operating rods, followers, arm followers, and firing pins selected for this investigation. These components were vapor-cleaned with trichlorethylene and then processed with finish 5.3.1.2 of Military Standard 171. The components were grit-blasted, coated with manganese phosphate, and given a supplementary oil treatment with MIL-L-644 preservative oil.

An outdoor storage shed and a static humidity cabinet were utilized as testing areas for this investigation.

The outdoor storage shed was located on the roof of Springfield Armory Laboratory. This storage shed was a triangular wooden structure approximately 5 feet high, 3 feet deep at the base, and 6 feet wide (Figure 1). Three hinged, overlapping steel doors on each side provided some protection against the direct exposure to extreme weather conditions.

PROCEDURE - Continued

This type of outdoor exposure afforded a good test for evaluating packaging materials since it provided more severe test conditions than minimum warehouse storage.

The static humidity cabinet used in this investigation was approximately 2-3/4 feet high, 2-1/3 feet wide, and 9-1/3 feet long. The temperature maintained in the cabinet throughout the test was 100°F ±5°F with the relative humidity controlled at 95% - 100%.

The submethods investigated were divided into three groups: The first group investigated included containers made of waterproof-vaporproof material that consisted of 1A-8 and 1A-15 submethods. The second group included containers of greaseproof and/or waterproof barriers that consisted of submethods 1C-1, 1C-2, 1C-5, and a polyester film laminated with polyethylene which was considered as a 1C-1 submethod. The third group included Method 1 unit packs that consisted of a clear polystyrene vial with a snap-on polyethylene cover and a modified 1C-5 submethod. The modification consisted of the taping of only the closure of the fiberboard box.

The test components were packaged with VCI material conforming to MIL-I-3420, Type I, in various containers. Approximately half of each group was stored in a static humidity cabinet and the remaining half was stored in an outdoor shed. The submethod used for the individual components was determined by the suitability of the submethod to the unit pack.

Approximately two to three control packs were prepared containing selected M1 components. These components were cleaned and processed in a similar manner as outlined in cleaning process C-7 of MIL-P-116 followed by finish 5.3.1.2 of Military Standard 171. These packs did not have VCI material. Approximately two to three packs were stored in the outdoor shed and also in the static humidity cabinet.

The packs were checked monthly in the static humidity cabinet for 12 months with particular concern for the condition of the unit pack, mold growth, condition of the seals, and corrosion-resistant effects by the VCI materials. The various unit packs stored in the outdoor shed were similarly checked monthly for the first 18 months after which they were stored for an additional 18 months and then checked for effects of 36 months outdoor storage. The unit packs were checked sporadically during the last 18 months in the outdoor storage shed.

PROCEDURE - Continued

The control unit packs which did not have VCI were similarly checked at the same time as the test packs in both the static humidity cabinet and in the outdoor storage shed. The control packs, however, were prepared and stored in the respective test apparatus approximately 3 weeks after the start of the test. These controls were used to provide a yardstick with which to evaluate the final results and did not serve as the ultimate criteria for comparative evaluation.

The first unit package investigated was a vial container made of transparent polystyrene with a snap-on polyethylene cap. The vial was approximately 1 inch in diameter and 2 inches in height. Initial examination of this type of container indicated that it may be utilized as a Method 1 pack which in addition could provide an efficient nondestructive check on the condition of the packaged component.

The second type of packaging material was that of heat-sealable polyester film. This material which was sealed on all four sides provided a transparent submethod 1C-1. This transparent property of the heat-sealable polyester film provided ideal nondestructive inspection conditions.

The third type of unit package investigated was a sealed waterproof-vaporproof bag, as specified in submethod 1A-8 of MIL-P-116, with a barrier material conforming to MIL-B-131, Class 2.

The submethod 1A-15 of MIL-P-116 was investigated with the following materials. This waterproof-vaporproof container-bag submethod was made of slightly different materials. One group of submethod 1A-15 was made of a paperboard container in accordance with Specification PPP-B-566 and covered with MIL-B-131B Class 2 barrier material. The second group of submethod 1A-15 was made of fiberboard boxes conforming to Specification PPP-B-636. The individual containers were taped with PPP-T-76 material and the overwrap bag was made of MIL-B-131 Class 1 material.

The greaseproof-waterproof sealed bags used for submethod 1C-1 were fabricated from MIL-B-121A, Grade A, Type 2, Class 1, material.

The materials used for submethod 1C-2 consisted of a paper board container conforming to Specification PPP-B-566 with the waterproof barrier material conforming to Specification MIL-B-13239A, Grade A, Type B-2, Class 2.

PROCEDURE - Continued

The final submethod investigated was 1C-5. The containers were fabricated from fiberboard material PPP-B-636 into boxes 4" x 4" x 4". The sides and the flaps were sealed with PPP-T-76 tape.

A slight modification of this 1C-5 submethod was made by partially taping the fiberboard box at the flaps or closures. This deviation changed the classification of the pack to a Method 1.

The various unit packs are identified in Figure 2.

III. RESULTS AND DISCUSSION

a. Vial Packs in Humidity Cabinet - Table 1

After one month's exposure in the humidity cabinet, all packs with VCI liners contained a slight amount of moisture indicating the poor seal made by the polyethylene cap. The apertures with VCI rusted after 1 month's exposure; whereas, the hammer spring housings rusted after 4 months' exposure. The moisture content increased in the vials until there was approximately 1/8 inch of water, inside, after 6 months' exposure. The test was terminated after 6 months' exposure (Figure 2).

The control packs exhibited rust on the trigger pins after the third inspection check. However, since the control packs were not placed in the respective testing areas at the same time as the other packs, this represented a little more than 2 months' exposure. After the fourth inspection check, all the control packs rusted.

It is apparent that the VCI did not provide the added corrosion-resistant protection for the components under such adverse conditions. In addition, after 2 to 3 months' storage in the humidity cabinet, the polystyrene vials exhibited cracking. This container was not satisfactory for storage under abnormally wet conditions.

b. Vial Packs in Outdoor Storage Shed - Table 2

The vial packs with VCI were satisfactory; only one of five samples exhibited rust. One hammer spring housing had a very small rust spot. However, this condition resulted after 35 months' exposure.

III. RESULTS AND DISCUSSION - Continued

The control vials, on the other hand, started to rust after 23 months' exposure. At that time, three of four vials had slight rust. This rust condition continued until the end of the 3-year test period. Three of the four control packs contained components on which the rust varied from light to moderate.

Hairline cracks approximately 1/8 inch long appeared on the vials after 8 months' exposure. Cracks progressed approximately 1/4 inch to 1/2 inch long in 20 months. At the end of the 3-year test period, all vials had cracks of various sizes.

The poor aging properties of polystyrene was evidenced by the crazed surface. The vial packs with VCI had very slight rust on only one of five packs; whereas, the control vial packs had rust on three of the four packs. The VCI appeared to provide beneficial corrosion-resistant properties for the components during the test period.

c. Heat-sealable Polyester Film in Humidity Cabinet - Table 3

After exposure of 1 month in the humidity cabinet, one of the polyester packs with VCI had leaked because of a poor seal. As a result, the inclosed component, a butt swivel, started to rust. No moisture was observed in any polyester pack after the first month. However, after the second month, slight moisture was observed in all the packs. This condition continued and, at the end of 8 months' exposure, condensation was observed inside all packs. One other failure in the VCI packs was noted at the end of 7 months. This was a slightly rusted aperture. The amount of rust on this component likewise did not increase after 12 months' exposure.

A slight rust condition was noted with the control group after the fourth periodic inspection. This rust condition progressively worsened until both components had become rusted at the end of the test period.

III. RESULTS AND DISCUSSION - Continued

d. Heat-sealable Polyester Film in Outdoor Storage Shed - Table 4

Polyester envelopes were examined through the transparent material during the 3-year test period. No rust was detected throughout the first 33 months of exposure. After the 15th month, one pack containing an extractor was blown out of the shed and lost. The periodic examination after 27 months indicated one missing pack. This pack was subsequently found frozen in the snow on the roof. This pack was opened and the extractor was found in good condition.

At the end of 3 years, all packs were opened and examined. The two controls used were satisfactory. The VCI liners in the twelve remaining packs indicated that all had contained condensation in varying amounts. One of the extractor packages contained water; the extractor was heavily rusted. This condition was evidently due to barrier failure. Two other components, an extractor and a butt swivel, were found to be very slightly rusted. This rust was so slight that it became evident only on close examination.

It is apparent that the static humidity cabinet provided more severe testing conditions than the outdoor storage shed. In addition, the testing conditions of the outdoor storage shed were not sufficiently severe to evaluate satisfactorily the effectiveness of the VCI material in the pack.

e. Submethod 1C-1, Humidity Cabinet - Table 5

Thirteen 1C-1 packs with two controls placed in the humidity cabinet were found 1 month later to vary between damp and wet. After 2 months, two packs were withdrawn. The inside of these packs was wet and the VCI liners were thoroughly soaked. The packaged rear sight covers were rusted. A third pack was opened after 3 months; this pack was found in a similarly rusted condition. After 4 months, all remaining 1C-1 packs were removed. The controls were rusted. The VCI lined packs were also rusted, but not so severely as the controls. No rust was observed on the component that had been in contact with the VCI liner. It is quite possible that all the packs rusted within the first month.

f. Submethod 1C-1, Outdoor Storage Shed - Table 6

Because of the physical construction and the location of the outdoor shed, packs stored there were subjected to a natural weather cycling. During the 3 years' storage, the packages were on occasion covered with snow, dried out, rained upon, and thoroughly drenched when precipitation was accompanied by high winds. After the 4th, 5th, and 6th month, respectively, the packages were withdrawn and the

components examined. The components in three of the 4 withdrawn packs had no evidence of rust; these packs appeared to be in satisfactory condition despite the rather severe weather conditions during that time interval. The fourth package, however, had leaked and the inclosed component had rusted slightly.

After 12 months' exposure, two additional packs were opened, but no rust was found. At the 18th-month interval, a package was found on the open roof. This pack had been blown out of the outdoor storage shed during the 17th month and had been wholly exposed to the inclemencies of the weather. The component had slight rust; however, it was usable.

At the end of the 36-month test period, four packs with VCI were examined. Three of these packaged components were satisfactory, whereas the fourth was heavily rusted.

Two controls without VCI were used for the 1C-1 submethod. One control pack was blown out of the outdoor storage shed during the 9th month and was not recovered. The remaining pack was opened at the end of the 3-year test period; no rust was observed on the component.

The evaluation of the effectiveness of the VCI material with submethod 1C-1 could not be made within the 3-year test period.

g. Submethod 1C-2, Humidity Cabinet - Table 7

After 1 month's exposure, light mold was observed on some wet packs. This mold condition affected all the packs within 4 months and increased in severity until the termination of the test at 12 months. At the end of 4 months' exposure, three packs containing hammers were removed from the test apparatus and examined. Mold growth was observed inside the pack and, in addition, the VCI liners were wet. None of the hammers had rust, however. A control pack which did not have a VCI liner was also examined at the same time. The packaging materials were similarly affected by moisture and heavy mold; light rust was observed on the component.

At the end of 6 months' exposure, three additional unit packs containing hammers and a front sight were examined. Although all the packs were thoroughly wet, the individual components had not rusted. The remaining control pack was also examined at this time and, as anticipated, the component was rusted (Figure 4).

The final inspection made at the end of 1 year indicated the poor condition of the barrier material. Since MIL-B-13239A material is only waterproof and not also vaporproof, the packages were tested under extremely adverse conditions, 95% relative humidity. Of the remaining six units, four were found in satisfactory condition, no rust areas were observed. The remaining two components had very slight evidence of rust.

This particular test indicated the relative value of VCI paper under extremely adverse conditions and points out that even under extended storage the added protection of VCI compensates for the use of a lower packaging submethod or material.

h. Submethod 1C-2, Outdoor Storage Shed - Table 8

The components with VCI in the unit packs were examined after the 4-month and 6-month test interval, and at the end of the 36-month test period. The control packs which did not have VCI were checked at the 6-month test interval and at the end of the investigation.

No rust was observed after 4 months' exposure and after 6 months' exposure. In addition, the control component was satisfactory. The results of the examination at the end of the test revealed only one unsatisfactory package. This was a VCI-lined pack which had become thoroughly soaked; this condition may have been due to its unfavorable position in the outdoor storage shed with respect to protection from inclement weather. This pack consisting of a hammer practically fell apart when opened, but had only light rust in one area.

i. Submethod 1C-5, Humidity Cabinet - Table 9

Heavy mold was evident on the exterior of these packs after 2 months' exposure. After 4 months' exposure, two 1C-5, two 1C-5 (modified) and one control package were removed from the test and examined. All of the packages were wet and had mold growth on both the exterior and the interior surfaces. All of the components examined had rusted after 6 months' exposure. Although the initial check was made after 4 months' exposure, it is reasonable to assume that the rust condition of all the components may have occurred at an earlier time.

After 6 months' exposure, the wet moldy condition of the containers and the liners had worsened. The fiberboard containers were saturated and delaminated. The contol and the 1C-5 (modified) packaged components were heavily rusted, whereas the components in

the 1C-5 packs had heavy rust in isolated areas only (Figure 3).

The 1C-5 and the 1C-5 (modified) containers can be considered unsatisfactory because of the extreme susceptibility of these containers to mold growth. This mold growth consequently accelerated the deterioration of the pack to the extent that preservation of the contents became unpractical.

j. Submethod 1C-5 and 1C-5 (Modified), Outdoor Storage Shed - Table 10

All packaging materials remained in good condition throughout the 36 months' exposure in the outdoor storage shed. The containers were dry after this 3-year storage, but the moisture stains indicated the wet and the dry cycling to which these containers were subjected.

The control package was opened at the end of a 4-month exposure interval; no rust was observed on the packaged component. The pack was resealed and returned to the test area. After 6 months and after 12 months, respectively, examinations showed that the components were in an excellent state of preservation. At the end of the test, the tape on the containers had started to loosen. The 1C-5 and 1C-5 (modified) pack afforded satisfactory protection for the components. The trigger guard in the control pack had slight rust on the surface. However, the limited number of controls prohibited a more complete evaluation of the effectiveness of the VCI material during the test period.

k. Submethod 1A-8, Humidity Cabinet - Table 11

The packaging material had light mold growth on the majority of the packs after the first month's exposure. One pack containing a VCI-wrapped hammer plunger, was dislodged from the test rack between the first and the second month of the test. This component was recovered at the bottom of the cabinet, entirely immersed in water. The pack, therefore, was removed from the test.

At the end of the 5th month, one pack containing a hammer spring was opened. The component was satisfactory with no evidence of rust. The following month, three control components were examined; two of these components had no rust.

These packs were examined monthly for exterior conditions and then opened after the 12th month. The barrier material was wet with mold growth on the exterior. The control packs which did not have VCI appeared damp inside. The component packed with the VCI liner was satisfactory; no rust was observed. However, slight rust was observed on all the control packs. (Fig. 5)

l. Submethod 1A-8, Outdoor Storage Shed - Table 12

After 36 months' exposure, all package exteriors were in good condition. The packaged components protected with VCI liners were without rust. Of the unlined 1A-8 packs, one was missing and a second pack had a slight amount of rust on the component.

m. Submethod 1A-15, Humidity Cabinet - Table 13

Two components, a trigger guard and a front sight, were used with this submethod in the static humidity cabinet. Although the barrier sustained light mold growth and was wet, the interiors of the packages were dry and in good condition. No rust was found on these components after 12 months' exposure.

n. Submethod 1A-15, Outdoor Storage Shed - Table 14

A trigger guard and a front sight were individually wrapped with VCI liners and stored in the outdoor storage shed.

After 36 months' exposure, the packaged components, the containers, the VCI liners, and the barrier material were in satisfactory condition.

IV. CONCLUSIONS

a. Direct measurement or correlation is not apparent between storage time in the outdoor shed and in the static humidity cabinet.

b. Test conditions are more severe in the static humidity cabinet than in the outdoor storage shed. However, these conditions represent only actual extremes of high temperature and high humidity.

c. Polystyrene vials were not suitable unit packs for either the long-term shed storage or for the high humidity conditions.

IV. CONCLUSIONS - Continued

d. The use of VCI with heat-sealable polyester material provided satisfactory protection in the humidity cabinet.

e. The use of VCI material in submethod 1C-2 was beneficial to the packaged components in the humidity cabinet.

f. Submethods 1C-1, 1C-5 and 1C-5 (modified) with VCI were unsatisfactory in the humidity cabinet.

g. Submethods 1A-8 and 1A-15 provided satisfactory protection in the humidity cabinet for 12 months when VCI material was used.

h. Testing conditions provided by the outdoor storage shed were not sufficiently severe to adequately evaluate the use of VCI material.

i. Test results indicate that submethod 1C-2 and heat-sealable polyester packs containing VCI may be adequate for Level A Protection of specific components.

j. Materials having a WVTR (water-vapor transmission rate) value of 0.07 grams, such as MIL-B-131, and 0.2 grams for heat-sealable polyester film provided satisfactory protection without any impairment of the efficiency and effectiveness of the VCI materials.

APPENDIX A

TABLES (14)

TABLE #1

VIAL PACK - HUMIDITY CABINET

COMPONENT	VCI	STORAGE TIME IN MONTHS											
		1	2	3	4	5	6	7	8	9	10	11	12
HAMMER SPRING HOUSING	YES	NR	NR	NR	SR	MR	MR						
HAMMER SPRING HOUSING	YES	NR	NR	NR	SR	MR	MR						
APERTURE	YES	LR	LR	LR	LR	with-drawn							
APERTURE	YES	LR	LR	LR	MR	with-drawn							
APERTURE	YES	HR	with-drawn										
CONTROL													
HAMMER SPRING PLUNGER	NO	NR	NR	NR	MR	MR	with-drawn						
HAMMER SPRING PLUNGER	NO	NR	NR	NR	MR	MR	with-drawn						
TRIGGER PIN	NO	NR	NR	R	HR	with-drawn							
TRIGGER PIN	NO	NR	NR	R	HR	with-drawn							

Key to Abbreviation

NR - No Rust
LR - Light Rust
MR - Moderate Rust
SR - Slight Rust
HR - Heavy Rust
R - Rust

TABLE #2

VIAL PACK - OUTDOOR STORAGE SHED

COMPONENT	VCI	STORAGE TIME IN MONTHS																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	36
HAMMER SPRING HOUSING	YES	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	VSR
HAMMER SPRING HOUSING	YES	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	NR
HAMMER SPRING HOUSING	YES	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	NR
APERTURE	YES	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	NR
APERTURE	YES	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	NR
CONTROLS																						
HAMMER SPRING PLUNGER	NO	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	LR
HAMMER SPRING PLUNGER	NO	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	MR
TRIGGER PIN	NO	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	MR
TRIGGER PIN	NO	S	S	S	NC	S	S	S	S	S	S	W	S	S	S	S	S	S	S	S	S	NR

Key To Abbreviation

S - Satisfactory
NC - Not Checked - Snow Cover
W - Wet
VSR - Very Slight Rust
LR - Light Rust
MR - Moderate Rust
NR - No Rust

TABLE #3

HEAT-SEALABLE POLYESTER PACK - HUMIDITY CABINET

COMPONENT	VCI	STORAGE TIME IN MONTHS											
		1	2	3	4	5	6	7	8	9	10	11	12
HAMMER SPRING PLUNGER	YES	S	S	S	S	S	S	S	S	S	S	S	NR
HAMMER SPRING PLUNGER	YES	S	S	S	S	S	S	S	S	S	S	S	NR
EXTRACTOR	YES	S	S	S	S	S	S	S	S	S	S	S	NR
EXTRACTOR	YES	S	S	S	S	S	S	S	S	S	S	S	NR
APERTURE	YES	S	S	S	S	S	S	LR	LR	LR	LR	LR	LR
APERTURE	YES	S	S	S	S	S	S	S	S	S	S	S	NR
HAMMER SPRING HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	NR
HAMMER SPRING HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	NR
FIRING PIN	YES	S	S	S	S	S	S	S	S	S	S	S	NR
BUTT SWIVEL	YES	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR
TRIGGER PIN	YES	S	S	S	S	S	S	S	S	S	S	S	NR
TRIGGER PIN	YES	S	S	S	S	S	S	S	S	S	S	S	NR
CONTROL													
TRIGGER	NO	S	S	S	SR	MR	MR	HR	HR	HR	HR	HR	HR
TRIGGER	NO	S	S	S	SR	MR	MR	HR	HR	HR	HR	HR	HR

Key to Abbreviation

S- Satisfactory
NR - No Rust
LR - Light Rust
MR - Moderate Rust
HR - Heavy Rust

TABLE #4

HEAT-SEALABLE POLYESTER PACK - OUTDOOR STORAGE SHED

COMPONENTS	VCI	STORAGE TIME IN MONTHS																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	36
EXTRACTOR	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
EXTRACTOR	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
EXTRACTOR	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
EXTRACTOR	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	lost						
HAMMER SPRING HOUSING	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
HAMMER SPRING HOUSING	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
APERTURE	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
APERTURE	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
HAMMER SPRING PLUNGER	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
HAMMER SPRING PLUNGER	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
BUTT SWIVEL	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
FIRING PIN	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
TRIGGER PIN	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
SAFETY LATCH	YES	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
CONTROLS																						
TRIGGER PIN	NO	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
SAFETY CATCH	NO	S	S	S	NC	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR

Key to Abbreviation
NC - Not Checked - Snow Cover
S - Satisfactory
NR - No Rust

TABLE #5

1C-1 - HUMIDITY CABINET

COMPONENT	VCI	STORAGE TIME IN MONTHS											
		1	2	3	4	5	6	7	8	9	10	11	12
REAR SIGHT COVER	YES	VW	VW	VW	R								
REAR SIGHT COVER	YES	VW	VW	VW	R								
REAR SIGHT COVER	YES	VW	VW	VW	R								
REAR SIGHT COVER	YES	VW	VW	HM	R								
REAR SIGHT COVER	YES	VW	VW	LM	R								
REAR SIGHT COVER	YES	VW	VW	LM	R								
REAR SIGHT COVER	YES	SW	VW	LM	R								
REAR SIGHT COVER	YES	SW	VW	LM	R								
REAR SIGHT COVER	YES	VLM	D	R									
REAR SIGHT COVER	YES	VLM	R										
REAR SIGHT COVER	YES	VLM	D	R									
REAR SIGHT COVER	YES	VLM	R										
BUTT SWIVEL PLATE	YES	VLM	D	W	R								
						CONTROL							
CONTROL	NO	VW	VW	HR									
CONTROL	NO	LM	LM	LR									

Key to Abbreviation

VW - Very Wet
SW - Slightly Wet
VLM - Very Light Moisture
LM - Light Moisture
HM - Heavy Moisture
D - Damp
LR - Light Rust
HR - Heavy Rust
R - Rust

TABLE #6

1C-1 - OUTDOOR STORAGE SHED

COMPONENTS	VCI	STORAGE TIME IN MONTHS																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	36
REAR SIGHT COVER	YES	S	S	S	HR																	
REAR SIGHT COVER	YES	S	S	S	W	HR																
REAR SIGHT COVER	YES	S	S	S	W	S	HR															
REAR SIGHT COVER	YES	S	S	S	W	S	LR															
REAR SIGHT COVER	YES	S	S	S	W	S	S	S	S	S	S	W	HR									
REAR SIGHT COVER	YES	S	S	S	W	S	S	S	S	S	S	W	HR									
REAR SIGHT COVER	YES	S	S	NC	W	S	S	S	S	S	S	W	S	W	S	D	S	D	S	S	W	NR
REAR SIGHT COVER	YES	S	S	S	W	S	S	S	S	S	S	W	S	W	S	D	S	D	S	S	W	NR
REAR SIGHT COVER	YES	S	S	S	W	S	S	S	S	S	S	W	S	W	S	D	S	D	S	S	W	HR
REAR SIGHT COVER	YES	S	S	S	W	S	S	S	S	S	S	W	S	W	S	D	S	D	S	S	W	NR
LATCH CLIP	YES	S	S	S	W	S	S	S	S	S	S	W	S	W	S	D	S	D	SR			
FRONT SWIVEL	YES	S	S	S	W	S	S	S	S	S	S	W	S	W	S	D	S	D	lost			
											CONTROL											
BASE REAR SIGHT	NO	S	S	NC	W	S	S	S	S	S	S	W	S	W	S	D	S	D	S	S	W	NR
CONTROL	NO	S	S	NC	W	S	S	S	lost													

Key to Abbreviation

LR - Light Rust
HR - Heavy Rust
NR - No Rust
W - Wet
D - Damp
NC - Not Checked - Snow Cover
S - Satisfactory

TABLE #7

1C-2 - HUMIDITY CABINET

COMPONENT	VCI	STORAGE TIME IN MONTHS											
		1	2	3	4	5	6	7	8	9	10	11	12
HAMMER	YES	N.Mo	L.Mo	L.Mo	N.R								
HAMMER	YES	N.Mo	L.Mo	L.Mo	N.R								
HAMMER	YES	L.Mo	L.Mo	L.Mo	N.R								
HAMMER	YES	L.Mo	H.Mo	H.Mo	H.Mo	H.Mo D	NR						
HAMMER	YES	N.Mo	L.Mo	L.Mo	L.Mo	H.Mo D	NR						
HAMMER	YES	L.Mo	H.Mo	H.Mo	H.Mo	H.Mo D	H.Mo W	H.Mo W	H.Mo W	H.Mo W	H.Mo W	H.Mo W	N.R.
HAMMER	YES	L.Mo	H.Mo	H.Mo	H.Mo	H.Mo D	H.Mo	H.Mo W	H.Mo W	H.Mo W	H.Mo W	H.Mo W	N.R.
HAMMER	YES	L.Mo	H.Mo	H.Mo	H.Mo	H.Mo D	H.Mo	H.Mo W	H.Mo W	H.Mo W	H.Mo W	H.Mo W	N.R.
HAMMER	YES	N.Mo	N.Mo	L.Mo	L.Mo	L.Mo D	L.Mo	H.Mo W	H.Mo W	H.Mo W	H.Mo W	H.Mo W	N.R.
FRONT SIGHT	YES	N.Mo	N.Mo	N.Mo	L.Mo	L.Mo W	NR						
FRONT SIGHT	YES	N.Mo	L.Mo	L.Mo	L.Mo	L.Mo W	L.Mo W	L.Mo W	L.Mo W	H.Mo W	H.Mo W	H.Mo W	S.R.
FRONT SIGHT	YES	N.Mo	L.Mo	L.Mo	L.Mo	L.Mo W	L.Mo W	L.Mo W	L.Mo W	H.Mo W	H.Mo W	H.Mo W	S.R.
CONTROL													
REAR SIGHT	NO	DRY	H.Mo	H.Mo D	L.R								
REAR SIGHT	NO	DRY	H.Mo	H.Mo D	H.Mo W	R							

Key to Abbreviation

N.Mo - No Mold
L.Mo - Light Mold
H.Mo - Heavy Mold
D - Damp
W - Wet
SR - Slight Rust
LR - Light Rust
R - Rust
NR - No Rust

TABLE #8

1C-2 OUTDOOR STORAGE SHED

COMPONENT	VCI	STORAGE TIME IN MONTHS																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	36
HAMMER	YES	S	LM	S	S	S	NR															
HAMMER	YES	S	LM	S	S	S	NR															
HAMMER	YES	S	LM	S	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR
HAMMER	YES	S	S	S	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR
HAMMER	YES	S	S	S	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR
HAMMER	YES	S	S	S	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR
HAMMER	YES	S	S	S	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR
HAMMER	YES	S	S	NC	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	SR
HAMMER	YES	S	S	NC	NR																	
FRONT SIGHT	YES	S	S	NC	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR
FRONT SIGHT	YES	S	S	NC	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR
FRONT SIGHT	YES	S	S	NC	NR																	
REAR SIGHT	YES	S	S	NC	S	S	NR															
CONTROL																						
BASE REAR SIGHT	NO	S	S	S	S	S	NR															
BASE REAR SIGHT	NO	S	S	S	S	S	S	S	S	S	S	W	S	W	W	W	S	D	S	S	S	NR

Key to Abbreviation

LM - Light Mold
NC - Not Checked - Snow Cover
W - Wet
S - Satisfactory
SR - Slight Rust
NR - No Rust
D - Damp

TABLE #9

1C-5 AND 1C-5 (MODIFIED) - HUMIDITY CABINET

COMPONENT	VCI	STORAGE TIME IN MONTHS											
		1	2	3	4	5	6	7	8	9	10	11	12
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	SR								
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	SR								
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	N Mo	N Mo	HR						
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	N Mo	N Mo	HR						
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	N Mo	N Mo	HR						
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	N Mo	N Mo	HR						
1C-5 (MODIFIED)													
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	LR								
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	LR								
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	N Mo	N Mo	HR						
TRIGGER HOUSING	YES	N Mo	N Mo	N Mo	N Mo	N Mo	HR						
TRIGGER HOUSING	YES	L Mo	N Mo	N Mo	N Mo	N Mo	HR						
1C-5 CONTROL													
BUTT PLATE	NO	N Mo	N Mo	N Mo	LR								
BUTT PLATE	NO	N Mo	N Mo	N Mo	N Mo	N Mo	HR						

Key to Abbreviation
N Mo - No Mold
L Mo - Light Mold
N Mo - Heavy Mold
S R - Slight Rust
L R - Light Rust
H R - Heavy Rust

TABLE #10

1C-5 AND 1C-5 (MODIFIED) - OUTDOOR STORAGE SHED

COMPONENT	VCI	STORAGE TIME IN MONTHS																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	36
TRIGGER HOUSING	YES	S	S	S	S	S	NR															
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	S	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	S	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	S	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	S	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	S	S	D	S	S	S	NR
1C-5 (MODIFIED)																						
TRIGGER HOUSING	YES	S	S	S	S	S	NR															
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	W	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	W	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	W	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	W	S	D	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	W	S	W	S	D	S	S	S	NR
1C-5 CONTROL																						
TRIGGER GUARD	NO	S	S	S	S	S	NR															
TRIGGER GUARD	NO	S	S	S	NR	S	S	S	S	S	S	S	NR	W	S	S	S	D	S	S	S	SR

Key to Abbreviation

R - Resealed
S - Satisfactory
SR - Slight Rust
NR - No Rust
W - Wet
D - Damp

TABLE #11

1A-8 - HUMIDITY CABINET

COMPONENT	VCI	STORAGE TIME IN MONTHS											
		1	2	3	4	5	6	7	8	9	10	11	12
HAMMER SPRING	YES	S.Mo.	H.Mo	H.Mo	N.C.	N.R.							
HAMMER SPRING	YES	S.Mo	H.Mo	H.Mo	N.C.	Mold	Mold	Mold	Mold	Mold	Mold	Mold	N.R.
HAMMER SPRING	YES	S	Lost										

CONTROL

CATCH OPERATING ROD	NO	L.Mo	L.Mo	L.Mo	N.C.	L.Mo	MR						
CATCH OPERATING ROD	NO	L.Mo	L.Mo	L.Mo	N.C.	L.Mo	NR						
CATCH OPERATING ROD	NO	L.Mo	L.Mo	L.Mo	N.C.	L.Mo	NR						
FOLLOWER	NO	S	Wet	Wet	N.C.	L.Mo	Lost						
HAMMER SPRING HOUSING	NO	S	L.Mo	L.Mo	N.C.	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	SR
HAMMER SPRING PLUNGER	NO	L.Mo	L.Mo	L.Mo	N.C.	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	SR
HAMMER SPRING PLUNGER	NO	L.Mo	L.Mo	L.Mo	N.C.	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	H.Mo	H.Mo	SR
ARM FOLLOWER	NO	L.Mo	L.Mo	L.Mo	N.C.	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	H.Mo	H.Mo	SR
ARM FOLLOWER	NO	L.Mo	L.Mo	L.Mo	N.C.	L.Mo	L.Mo	L.Mo	L.Mo	L.Mo	H.Mo	H.Mo	SR

Key to Abbreviation

S.Mo - Slight Mold
L.Mo - Light Mold
H.Mo - Heavy Mold
S. - Satisifactory
N.C. - Not Checked - Snow Cover
N R - No Rust
S R - Slight Rust
M R - Moderate Rust

TABLE #12

1A-8 - OUTDOOR STORAGE SHED

COMPONENT	VCI	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	36
HAMMER SPRING HOUSING	YES	S	S	NC	NC	S	NR															
TRIGGER	YES	S	S	NC	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	NR
REAR SIGHT	YES	S	S	NC	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	NR
CONTROL																						
CATCH OPERATING ROD	NO	S	S	S	NC	S	NR															
CATCH OPERATING ROD	NO	S	S	S	NC	S	NR															
CATCH OPERATING ROD	NO	S	S	S	NC	S	NR															
PLUNGER	NO	S	S	S	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	VSR
BUTT PLATE	NO	S	S	S	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	NR
FOLLOWER	NO	S	S	S	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	NR
ARM FOLLOWER	NO	S	S	S	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	NR
TRIGGER	NO	S	S	S	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	NR
TRIGGER	NO	S	S	S	NC	S	S	S	S	S	S	W	S	W	S	VW	S	D	S	S	W	lost

Key to Abbreviation

NC - Not Checked - Snow Cover
W - Wet
D - Damp
VW - Very Wet
S - Satisfactory
VSR - Very Slight Rust
NR - No Rust

TABLE #13

1A-15 - HUMIDITY CABINET

COMPONENT	VCI	STORAGE TIME IN MONTHS											
		1	2	3	4	5	6	7	8	9	10	11	12
TRIGGER GUARD	YES	S	S	S	NC	S	NC	S	S	S	S	S	NR D
FRONT SIGHT	YES	S	L Mo	L Mo	NC	L Mo	NC	L Mo	L Mo	L Mo	L Mo	L Mo	N R D

Key to Abbreviation

S - Satisfactory
NC - Not Checked - Snow Cover
L Mo - Light Mold
D - Dry
NR - No Rust

TABLE #14

1A-15 - OUTDOOR STORAGE SHED

COMPONENT	VCI	STORAGE TIME IN MONTHS																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	36
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR
TRIGGER HOUSING	YES	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	NR

Key to Abbreviation

S - Satisfactory
NR - No Rust

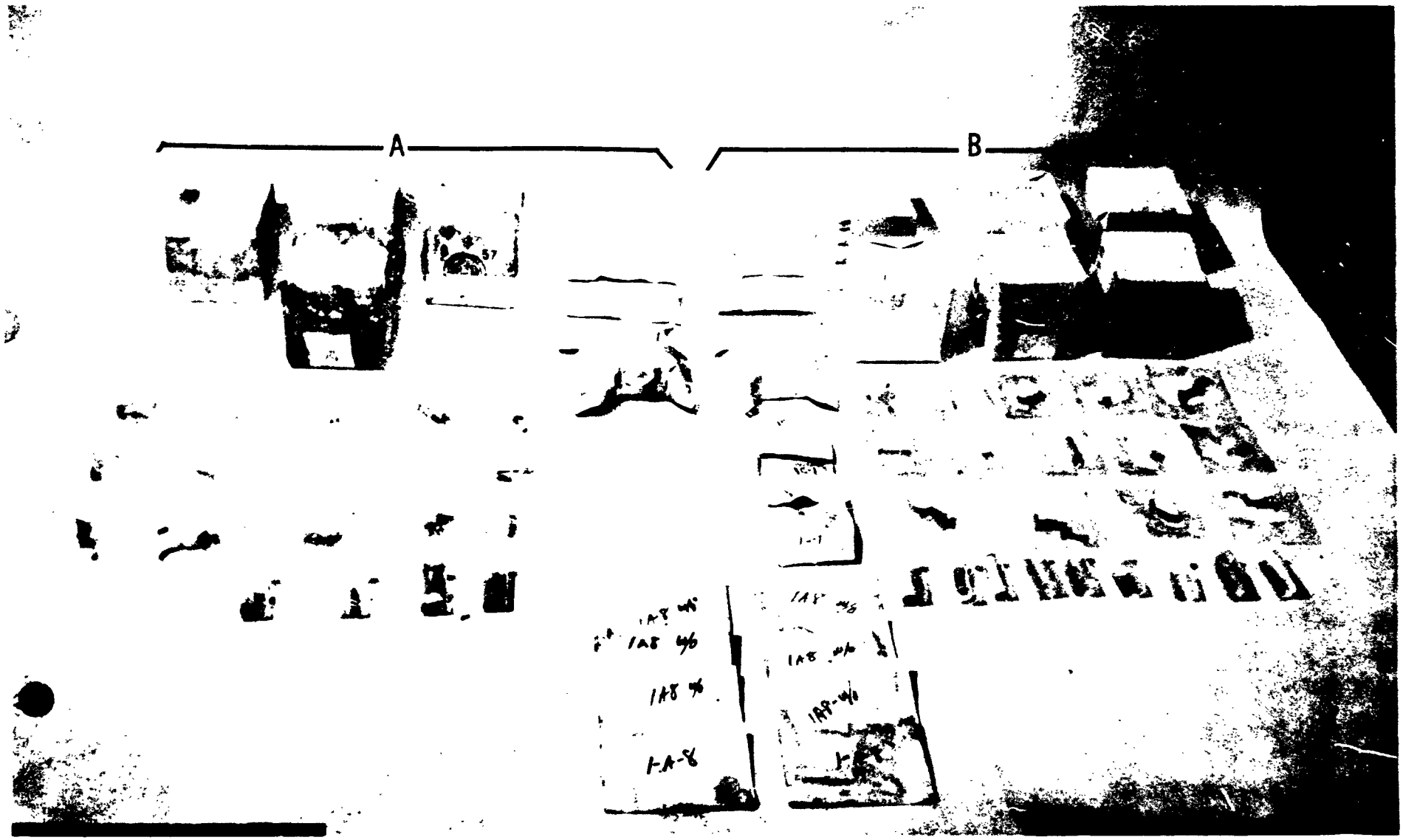
APPENDIX B

PHOTOGRAPHS

19-058-99/ORD-60	Figure 1	Outdoor Shed Exposure Site With Doors Open
19-058-96/ORD-60	Figure 2	Exterior Condition of Packages After 6 Months Storage Group A - Humidity Cabinet Group B - Outdoor Shed
19-058-95/ORD-60	Figure 3	View Showing Condition Of Packaging Materials In 1C5 Packs After 6 Months Storage Group A - Humidity Cabinet Group B - Outdoor Shed
19-058-97/ORD-60	Figure 4	Components and Packaging Materials After 6 Months Storage Group A - Humidity Cabinet Group B - Outdoor Shed
19-058-98/ORD-60	Figure 5	Packages Taken From Humidity Cabinet After One Year Storage
19-058-1356/ORD-60	Figure 6	Method 1C2 Packages After Three Years Exposure
19-058-1357/ORD-60	Figure 7	Method 1C1 Packages After 3 Years Exposure. Item At Extreme Right Sustained Heavy Rust
19-058-1358/ORD-60	Figure 8	Packages As Removed After Three Years Exposure In Outdoor Shed

19-058-99/ORD-60 SPRINGFIELD ARMORY 25 Jan 1960

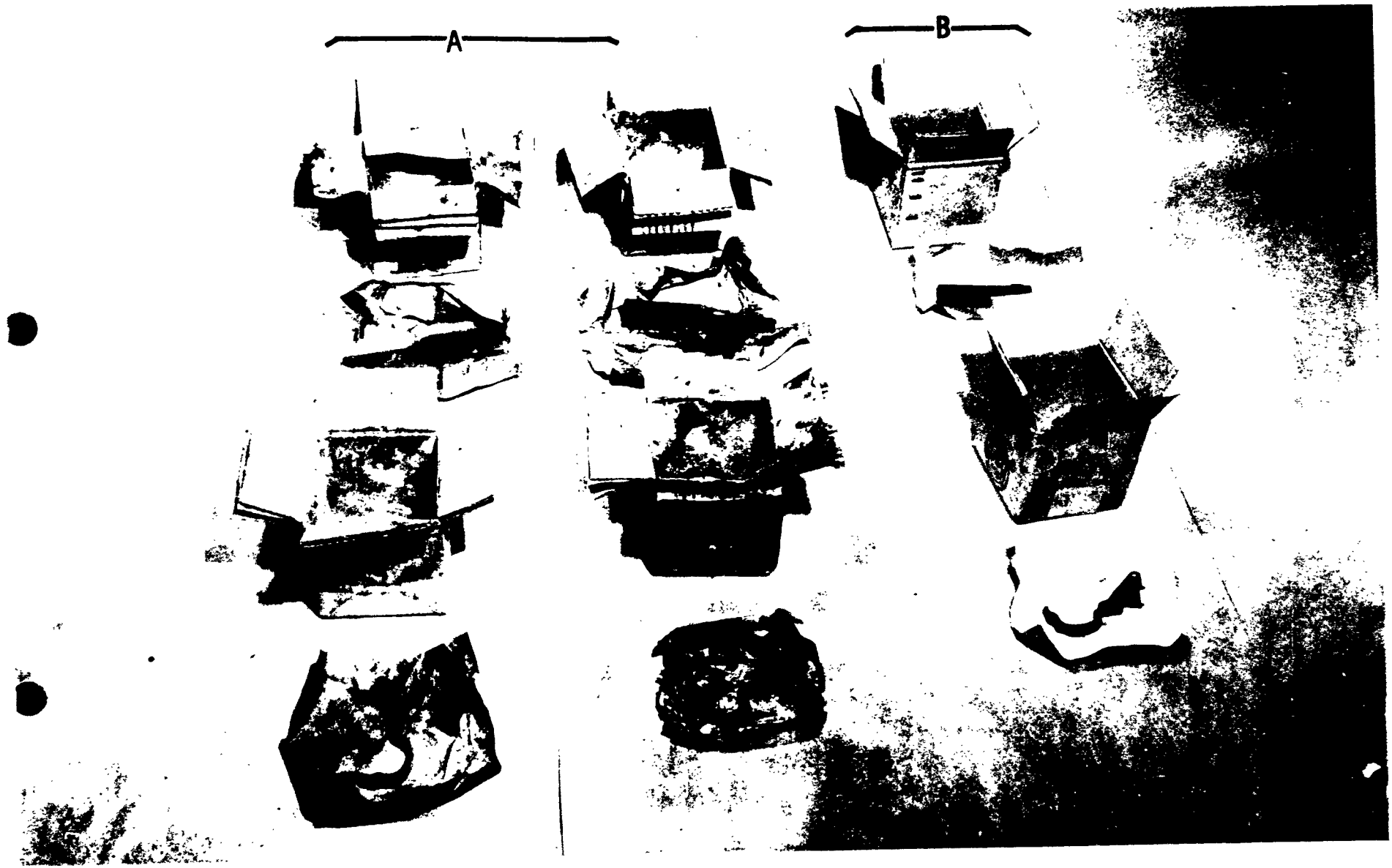
OUTDOOR SHED EXPOSURE SITE WITH DOORS OPEN



19-058-96/ORD-60 SPRINGFIELD ARMORY April 16, 1958

EXTERIOR CONDITION OF PACKAGES AFTER 6 MONTHS STORAGE

GROUP A - Humidity Cabinet GROUP B - Outdoor Shed



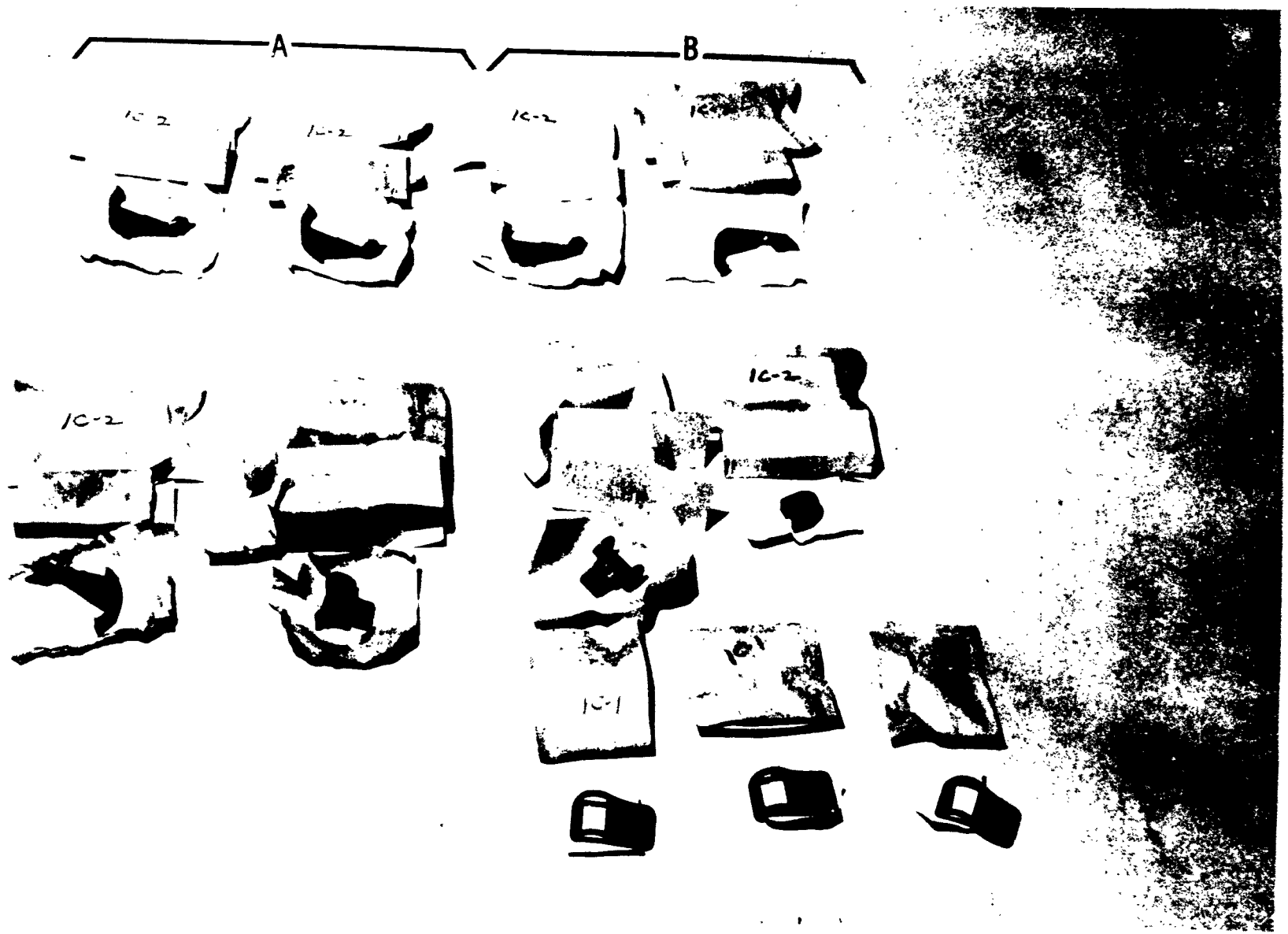
April 16, 1958

19-058-95/ORD-60

SPRINGFIELD ARMORY

VIEW SHOWING CONDITION OF PACKAGING MATERIALS
IN 1C5 PACKS AFTER 6 MONTHS STORAGE.

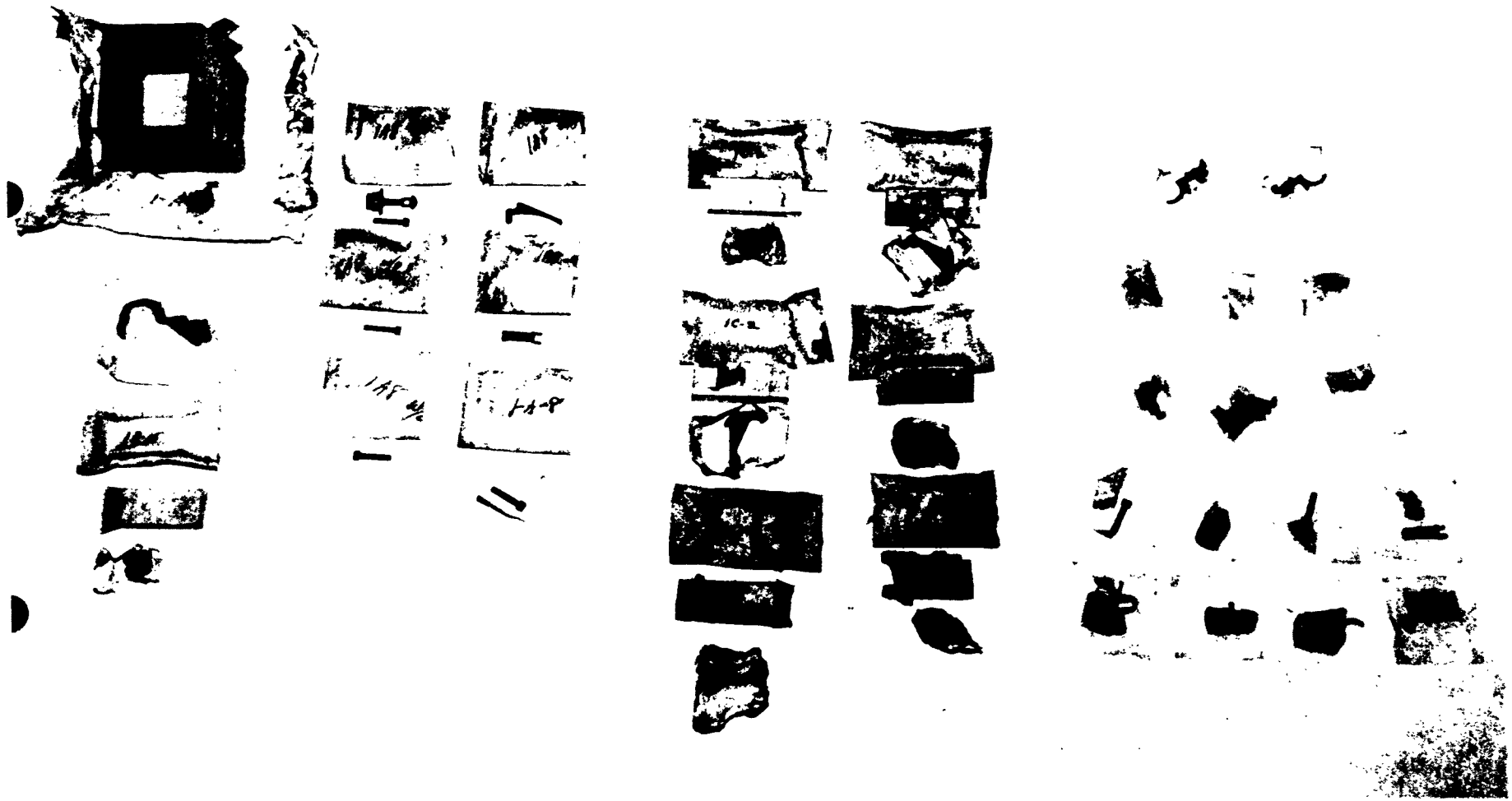
GROUP A - Humidity Cabinet GROUP B - Outdoor Shed



[illegible] ORD-60 SPRINGFIELD ARMORY April 16, 1958

COMPONENTS AND PACKAGING MATERIALS AFTER [illegible] MONTHS STORAGE

GROUP A - Humidity Cabinet GROUP B - Outdoor Shed



19-058-98/ORD-60 SPRINGFIELD ARMORY 25 Jan 1960

PACKAGES TAKEN FROM HUMIDITY CABINET AFTER ONE YEAR STORAGE

SPRINGFIELD ARMORY- ORDNANCE CORPS

[illegible]-1356/ORD-60 Date: 10 [illegible]ber 1960 Proj:

[illegible]METHOD IC2 PACKAGES AFTER [illegible] YEARS EXPOSURE

SPRING[illegible]ELD ARMORY- ORDNANCE CORPS

[illegible] 19-058-[illegible]7/ORD-60 Date: 10 November 1960 Proj:

METHOD 1C1 [illegible]CKAGES AFTER 3 YEARS EXPOSURE.

ITEM AT EXT[illegible]ME RIGHT SUSTAINED HEAVY RUST.

SPRINGFIELD ARMORY- ORDNANCE CORPS

Neg: 19-058-1358/ORD-60 Date: 10 November 1960 Proj:

PACKAGES AS REMOVED AFTER THREE YEARS EXPOSURE IN OUTDOOR SHED

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Springfield Armory, Springfield, Mass.
INVESTIGATION OF PACKAGING METHODS AND SUBMETHODS WITH VOLATILE-CORROSION-INHIBITOR TREATED MATERIALS, by G. Pributsky, Tech Rept SA-TR20-2313, 1 Aug 62, 45 pp incl illus.

Unclassified report.

Nonlimited distribution.

An investigation was made to evaluate the suitability of using various submethods with volatile-corrosion-inhibitor-treated materials in the packaging of small arms components. Packages were stored under two conditions: (1) in an outdoor shed to simulate minimum warehouse storage and (2) in a static humidity cabinet to simulate tropic storage. Heat-sealable polyester film with volatile-corrosion-inhibitor innerwrap provided satisfactory protection in the humidity cabinet for one year. Results of this investigation indicate that packaging submethods other than those specified in MIL-I-8574 can be satisfactorily used with VCI preservatives. Test procedures are described and results given.

1. Packaging
2. Corrosion Inhibitors
3. Barrier Materials

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